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Research Protocol

Physiotherapy Section

Effectiveness of Proprioception versus Craniocervical Flexion Training Exercises in Forward Head Posture Patients: A Research Protocol for a Randomised Controlled Trial

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ABSTRACT

Introduction: Forward Head Posture (FHP) is a forward inclination with increased flexion of the lower cervical and the upper thoracic regions, increased extension of the upper cervical vertebra and extension of the occiput on C1. Commonest impairments in subjects with FHP are neck pain, reduced cervical joint position sense, reduced strength of Deep Cervical Flexor (DCF) muscles and scapular muscle weakness.

Need of the study: Proprioception training improves cervical joint position sense and Craniovertebral Angle (CVA) by activating suboccipital muscles and enhancing head–eye coordination. Craniocervical flexion training strengthens DCFs, reduces overactivity of superficial neck muscles and improves posture. Although both treatments show benefits in FHP, there is limited literature directly comparing their effectiveness. This gap highlights the need for present study to evaluate and contrast these interventions for evidence-based clinical practice.

Aim: This study aims to compare the effectiveness of proprioception vs. craniocervical flexion training exercises in patients with FHP.

Materials and Methods: A single-blinded randomised three-arm parallel trial will be conducted at YMT College of Physiotherapy Kharghar, Navi Mumbai, Maharashtra, India from January 2023 to June 2026. Total 114 subjects will be randomly allotted to three groups with a 1:1:1 ratio. The first group will receive Proprioception training exercises along with conventional exercises, the second group will receive Craniocervical flexion training exercises along with conventional exercises and the third group will receive conventional exercises. Effect on pain, CVA, DCF activation and on cervical proprioception will be assessed after six weeks of intervention and statistical evaluation will be conducted using repeated measures of Analysis of Variance (ANOVA) or Friedman's test. A $p<0.05$ will be considered statistically significant.

Keywords: Exercise therapy, Muscle strength, Neck pain, Sensorimotor system

INTRODUCTION

Posture is described as the orientation of different body parts in space and it is one of the important health indicators and an important element to maintain balance [1]. FHP is a forward inclination with increased flexion of the lower cervical and the upper thoracic regions, increased extension of the upper cervical vertebra and extension of the occiput on C1 [2]. FHP is a prevalent postural variation in individuals across all age groups, from childhood to old age. According to a previous study, it has been proven that subjects with FHP have reduced CVA, reduced cervical joint position sense and reduced strength of DCF muscles [1].

Proprioception is a fundamental somatosensory function involving the transmission of afferent input from mechanoreceptors located in muscles, tendons, joint capsules and ligaments to the central nervous system, contributing significantly to neuromuscular coordination and joint stability [3]. In the cervical region, position sense is achieved through the integration of sensory input from cervical proprioceptors along with visual and vestibular systems, enabling accurate head orientation and coordinated movement in space [4]. Disruption of cervical afferent input, often due to postural abnormalities, muscle imbalance, or sustained mechanical stress, can impair this integrative mechanism, resulting in deficits in cervical joint position sense. This impairment is commonly assessed using cervical Joint Position Sense Error (JPSE), which reflects an individual's inability to accurately reposition the head to a predefined target position [4]. Studies have shown that individuals with FHP exhibit increased JPSE values, indicating diminished proprioceptive acuity [4,5]. Moreover, an inverse relationship has been observed between CVA and joint position sense, suggesting that greater postural deviation is associated with poorer proprioceptive function [4].

The DCF muscle group maintains the axis of motion of the atlantooccipital joint and is also important to stabilise motions and posture of the cervical spine. Impairments in these muscles lead to insufficient coordination, poor performance, overload and poor support to cervical articulation, which further leads to neck pain and altered cervical posture [6].

Available literature states the importance of manual therapy with stabilisation exercises [7], resistance and stretching training program [8], Pilates exercise program [9], DCFs strengthening and abdominal strengthening [10] in patients with FHP. A structured proprioceptive training program enhances cervical joint position sense and CVA in individuals with FHP by facilitating improved activation and coordination of the deep cervical and sub-occipital musculature. These muscles are rich in mechanoreceptors and play a crucial role in providing afferent input necessary for accurate head positioning and postural control. Exercises incorporating head-eye coordination and gaze stability further enhance the integration of cervical proprioceptive input with visual and vestibular systems, thereby improving sensorimotor control and postural awareness [11].

Proprioception training exercises and craniocervical flexion training are both recognised as effective interventions for improving

CVA and cervical joint position sense. Proprioceptive exercises primarily target sensorimotor control by enhancing afferent input and coordination between the cervical, visual and vestibular systems, whereas craniocervical flexion training focuses on activating and strengthening the DCF muscles to improve postural alignment and stability [11,12]. Although both approaches have demonstrated individual effectiveness in managing FHP, there is a lack of direct comparative studies evaluating their relative efficacy in this population. Therefore, a comparative analysis of these two intervention protocols is warranted to determine which approach yields superior outcomes in individuals with FHP.

Primary objectives

- To evaluate the effects of proprioception training exercises combined with conventional exercises in individuals with FHP.
- To evaluate the effects of craniocervical flexion training exercises combined with conventional exercises in individuals with FHP.
- To assess the effects of conventional exercises alone in individuals with FHP.

Secondary objectives

- To compare the outcomes of the two experimental interventions (proprioception training and craniocervical flexion training, each combined with conventional exercises) with conventional exercises alone.

Null Hypothesis: There will be no significant difference between proprioception training and craniocervical flexion training combined with conventional exercises in improving pain, cervical joint position sense, CVA and DCF strength in patients with FHP.

Alternative Hypothesis: There will be a significant difference in the effectiveness of proprioception training exercises and craniocervical flexion training exercises, both combined with conventional exercises, on outcome measures in patients with FHP.

REVIEW OF LITERATURE

Neck pain has frequently been linked to FHP, which is the forward displacement of the head on the cervical spine increased stress on the posterior cervical parts, a change in the length-tension relationship in the cervical muscles, an increase in muscular activity, a restriction in neck movement [2] and a reduction in cervical proprioception have all been proposed as consequences of this misalignment [5].

A systematic review concluded that among the 16 studies that investigated the efficacy of treatment programs for managing chronic pain in patients with FHP, 11 investigated the effect of exercise programs and five investigated the effect of manual therapy. Patients reported significant improvement in pain and disability after receiving treatment programs such as corrective postural exercises and special manual therapy techniques [13].

Similarly, Suresh N and Rajashekar A reviewed the effectiveness of proprioceptive training. Combining it with techniques like craniosacral therapy, cervical retraction and muscle energy methods enhances neck position sense, balance and pain relief. Exercises such as head repositioning, gaze stabilisation and eye-head coordination show positive outcomes. Specific tasks like eye tracking and gaze recognition help improve sensorimotor integration. These interventions contribute to better posture and reduced discomfort. Additionally, modalities like vibrating foam rollers may decrease muscle stiffness and pain. Overall, such approaches can improve both neck pain and proprioceptive accuracy [14].

A study done by Battal G et al., observed that, along with proprioception training exercises, if we add upper thoracic joint mobilisation technique for a duration of five weeks, it is more effective to improve CVA in asymptomatic college-going students who have FHP [11].

In a similar frame, Jull GA et al., assessed the effect of craniocervical flexor training exercises in chronic neck patients and concluded that it improved activation of deep neck flexors and reduced activity of sternocleidomastoid and anterior scalene muscles [6].

Blomgren J et al., conducted a systematic review, which analysed 12 randomised controlled trials including 502 participants with chronic neck pain to assess the impact of DCF training on physiological functions. The results provide strong evidence that DCF training enhances neuromuscular coordination and decreases superficial muscle activity, especially during the craniocervical-flexion test. It also contributes to improved cervical alignment and reduction of FHP. However, its influence on muscle strength, endurance, fatigability and muscle size remains limited or variable. DCF training primarily increases activation of deep muscles such as the longus colli, with little effect on superficial musculature [12].

To know better treatment approaches among Proprioception training exercises and craniocervical flexion training exercises, Gallego Izquierdo T conducted a randomised controlled clinical study where both approaches were compared in patients with chronic neck pain. Findings of present study proved that craniocervical flexion and Proprioception training improved activation of DCFs, pain and functional mobility in patients with chronic neck pain after giving intervention for two months, whereas Proprioception training was more effective in improving activation of DCF muscles [15].

Therefore, the study aims to find out the effectiveness of proprioception training exercises compared with craniocervical flexion training exercises in patients with FHP.

MATERIALS AND METHODS

A single-blinded randomised controlled trial with a three-arm parallel group design will be conducted in the YMT College of Physiotherapy Kharghar, Navi Mumbai, Maharashtra, India from January 2023 to June 2026.

Ethical clearance has been obtained from the Institutional Ethics Committee (IEC/COPT/2021/PhD-03/A-25110/2021). The trial has also been registered with the Clinical Trials Registry of India (CTRI/2023/08/056803).

The study protocol has been developed in accordance with the Consolidated Standards of Reporting Trials (CONSORT) guidelines and checklist.

Sample size calculations: Sample size is determined using the formula:

$$n = \frac{2(Z_{\alpha/2} + Z_{\beta})^2 \sigma^2}{d^2}$$

Where Z_{α} is the z variate of alpha error i.e., a constant with value 1.96, Z_{β} is the z variate of beta error i.e., a constant with value 0.84. Considering 80% power, at type I error to be 5%, Type II error to be 20%, True difference of at least 1cm (VAS) between the groups and standard deviation of 1.49 [16]:

Substituting the values in mentioned formula:

$n = \frac{2\,(2.8)^2\,(1.49)^2}{(1)^2}$

$n = 34.8$

The number of samples in each group comes 35. Considering 10% attrition rate, the sample size in each group comes 38/ group, hence the total sample size for this study is 114.

Inclusion criteria: Participants with neck pain specifically between the posterior part of the cervical spine and the interscapular region, in age group of 20-29, will be included. They should have a CVA less than 48 degrees [17].

Exclusion criteria: Patients with a history of tumours present at the cervical spine, any traumatic injury to the neck, previous

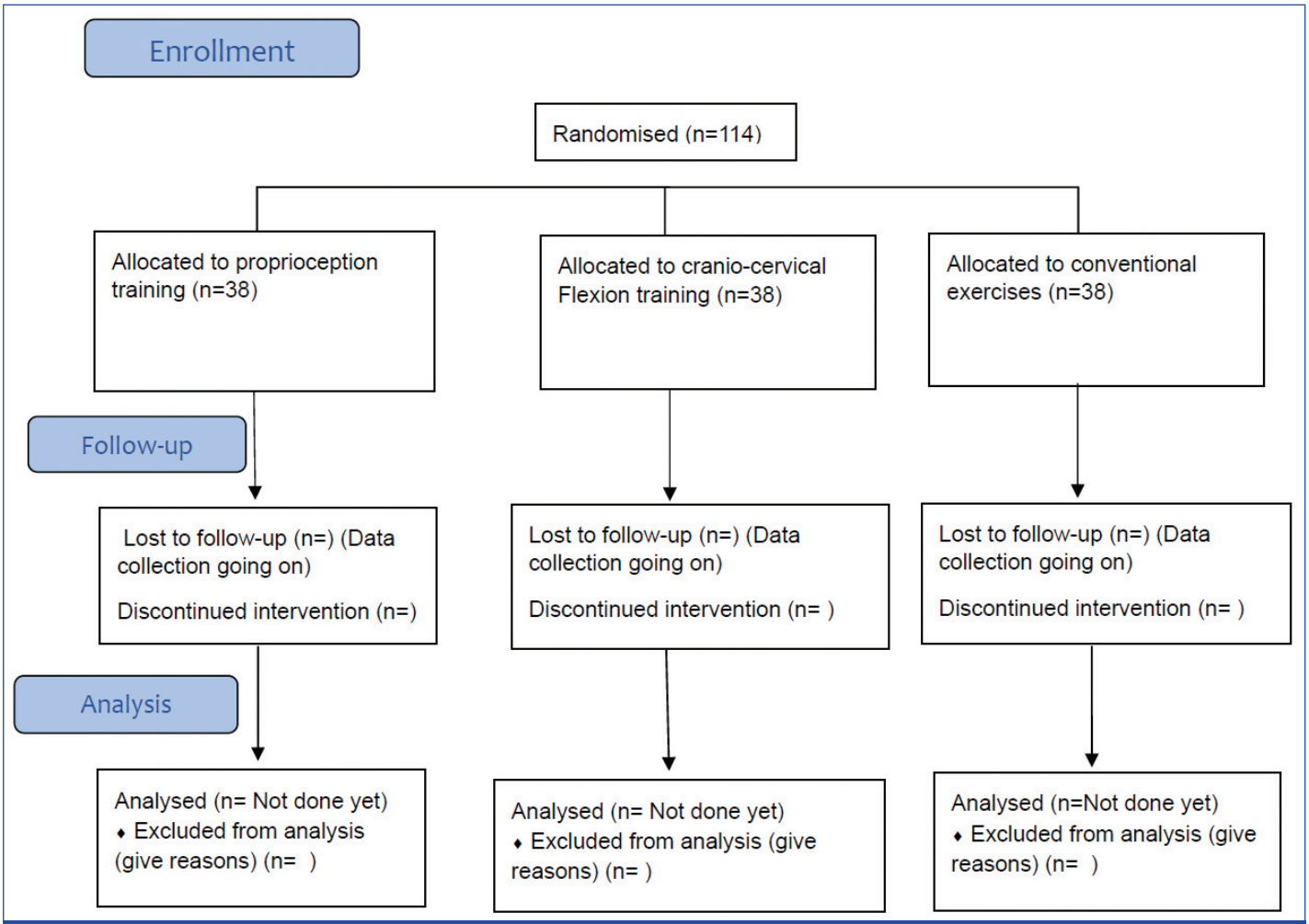
cervical surgery history, neurological conditions affecting the cervical spine and those who have taken physiotherapy treatment for the cervical spine in the last 12 months will be excluded from the study.

In present study, the convenience sampling method will be used and randomisation will be done using a computer-generated sequence. Allocation concealment will be done by the envelope method with Sequentially Numbered, Opaque, Sealed Envelopes (SNOSE) format. The assessor will be blinded to the pre and post-assessment of the participants [Table/Fig-1].

be given with 30 seconds hold and two repetitions [1]. Progression of these exercises will be done by increased resistance and hold [Table/Fig-4]. Participants will be receiving treatment interventions for six weeks, three days a week. Pre and post-treatment outcome measures will be assessed.

OUTCOMES

Cervical joint position sense will be assessed using the JPSE method to evaluate repositioning accuracy of the head. Participants will be in an upright posture, with the neutral head position serving as the



[Table/Fig-1]: Consolidated Standards of Reporting trials (CONSORT) flow diagram.

Study Procedure

Intervention Protocol

Group A will be given Proprioception training Exercises [Table/Fig-2] combined with conventional exercises; this group will be given retraining joint position and movement sense with a laser pointer attached to the forehead, gazing exercises, eye tracking exercises and Head–eye coordination exercises [18]. To progress these exercises complexity of the exercises will be increased by increased speed and complex patterns.

Group B will be given craniocervical flexion training exercises combined with conventional exercises. Craniocervical flexion training exercises will be given in two stages: phase 1 and phase 2 [Table/Fig-3] and progression of exercises will be done by increasing hold and repetition of exercises [15].

Group C will be given conventional exercises which consist of side-lying external rotation, Prone horizontal abduction with external rotation, Y to I exercises, chin tucks, pectoralis minor stretch, static sternocleidomastoid stretch and levator scapulae stretch. Strengthening exercises in this protocol will be given for two sets of 15 repetitions with 30s break in between, whereas static stretches will

Treatment	Description	Frequency and duration
Retraining joint position and movement sense with a laser pointer attached to the forehead	Participants will sit upright on a chair and kept their head at the neutral position while setting the laser light at the center of the screen in front of them. From this position, patients were asked to perform flexion, extension and rotations	1 set of 5 reps each direction with 30s break in between
Gazing Exercises	Fixing the gaze on particular target in which the participants perform active movements of the cervical spine (flexion, extension and rotation)	1 set of 5 reps each direction with 30s break in between
Eye tracking exercises	The participants follow with their eyes a target moving horizontally and vertically while keeping their head stationary with a neutral cervical spine	1 set of 5 reps each direction with 30s break in between
Head-eye coordination	The eye and head move in the same direction as the target	1 set of 5 reps each direction with 30s break in between

[Table/Fig-2]: Showing exercise protocol for Group A.

reference point. A laser device mounted on the head projected onto a grid placed at eye level to track movement. Participants will perform active neck movements and then attempt to return

Treatment	Description	Frequency and duration
Phase 1 -	The physiotherapist will teach the patient to perform slow and controlled craniocervical flexion movement in the supine position and gently nodding head by saying yes. The subject will concentrate on feeling the back of the head slide in cephalad and caudal direction on the supporting surface to ensure a sagittal rotation than a retraction movement.	At each target, they will be trained for maintain contraction for 10 seconds and 10 reps. Brief rest period will be given for 3-5 seconds. This training will be given up to the final target of 30 mm of Hg.
Phase 2	In this phase subjects will be trained to hold progressively increasing ranges of cranio-cervical flexion using bio-feedback. The air-filled pressure sensor will be placed behind the neck. The feedback dial will display the amount of pressure change as the cervical lordosis progressively flattens. The subject will be targeting 5 levels rom baseline of 20 mm of hg to 30 mm of hg. First physiotherapist will identify the base level where subject can hold contraction for 5 seconds without performing scapular retraction. Also, there should not be activation of superficial flexors which will be checked by palpation. Training will be commenced at the target level that the subject will achieve with correct craniocervical flexion movement.	

[Table/Fig-3]: Showing exercise protocol for Group B.

Exercise	Description
Side-lying external rotation	The patient will be in the side-lying position. The shoulder joint will be maintained in full abduction and internal rotation will be maintained. The elbow joint will be flexed to 90 degrees. After that, the patient will perform external rotation of the shoulder while maintaining the hand away from the body.
Prone horizontal abduction with external rotation	The patient will be in a prone lying position. The patient will be asked to perform horizontal abduction while maintaining the elbow in extension and shoulder external rotation. The patient will be instructed to squeeze the scapula and lift the arm towards the ceiling while the head and neck will be maintained into neutral position.
Y to I exercise	In a first stage, the patient will perform the Y position, for that patient will start with abduction of shoulder at 90 degrees and elbows will be flexed to 90 degrees. Patient will progress shoulder abduction while maintaining external rotation and elbows extension. At the end this position will be I.
Chin tuck	The patient will be in a supine lying position. Patient will be asked to maintain chin tuck that is the craniocervical flexion position. This position activates Deep Cervical Flexor (DCF) muscle group. This is gentle muscle activation exercise.
Pectoralis minor stretch	Patient will be in sitting position. While maintaining forearm in upright position therapist will ask patients to take both elbows away from body. So that affected side will be externally rotated and abducted to 90 degrees.
Static sternocleidomastoid stretch	Patient will be in sitting position, when therapist want to give stretch for right-side ask the patient to maintain chin tuck and slowly take left ear to left shoulder. Patient will rotate neck towards ceiling until slight stretch is felt. The patient will be asked to maintain slight pressure to have good stretch.
Static levator scapulae stretch	Patient will be in sitting position. The patient will be asked to rotate neck on opposite side, while maintaining chin tuck patient will look down towards floor and with other hand patient will apply pressure.

[Table/Fig-4]: Exercise protocol for Group C.

to the initial position with eyes closed. The difference between the starting and repositioned points will be measured in centimetres as JPSE. Three trials will be recorded and the average error will be used for analysis. Greater error values indicate impaired cervical proprioception [19].

Craniovertebral Angle (CVA): The photogrammetry method will be used. The participant will be standing in a natural, relaxed posture after attaining a self-balanced head and neck position, with the gaze directed forward at a fixed point to maintain horizontal alignment. The anatomical landmarks, namely the spinous process of C7 and the tragus of the ear, will be identified and marked on the lateral side. A lateral photograph will be captured using a camera positioned 1.5 meters away at shoulder height, ensuring no tilt or rotation. For angle determination, a horizontal line will be drawn through the C7 spinous process and a second line will be drawn connecting the C7 spinous process to the tragus of the ear using Kinovea (2025.1) software. The angle formed between these two lines will be recorded as the CVA [17].

The DCF strength will be measured by the craniocervical flexion test. This test consists of the precise and controlled performance of craniocervical flexion in supine lying. Subject has to maintain head nod position while maintaining pressure in pressure biofeedback from 20 mm of Hg to 30 mm of Hg. Performance index will be calculated by checking no of times the patient can hold for 10 sec for 10 repetitions at the perceived level. The maximum score is 100. Reliability for this performance index scoring is ICC=0.93 in subjects with neck pain [20].

The numeric pain rating scale will be used for pre- post assessment of pain.

All these parameters will be assessed at baseline and post-intervention i.e., after six weeks.

STATISTICAL ANALYSIS

Data will be compiled in Microsoft Excel (Microsoft 365) and analysed using Statistical Packages of Social Sciences (SPSS) version 27.0. Statistical tests will depend on data normality. For normally distributed continuous data, inter-group comparisons among more than two groups will use a One-way ANOVA or Kruskal-Wallis test as a non parametric alternative. Intra-group comparisons will involve a paired t-test or Wilcoxon signed-rank test for two observations. A $p<0.05$ will be deemed statistically significant.

REFERENCES

[1] Ruivo RM, Carita AI, Pezarat-Correia P. The effects of training and detraining after an 8-month resistance and stretching training program on forward head and protracted shoulder postures in adolescents: Randomised controlled study. Man Ther. 2016;21:76-82.
[2] Kisner C, Colby LA. Therapeutic exercise: Foundations and techniques. 5th ed. Philadelphia: FA Davis; 2007. p. 395-96.
[3] Richmond F, Abrahams V. What are the proprioceptors of the neck? Prog Brain Res. 1978;50:245-54.
[4] Treleaven J. Sensorimotor disturbances in neck disorders affecting postural stability, head and eye movement control. Man Ther. 2008;13(1):02-11.
[5] Lee MY, Lee HY, Yong MS. Characteristics of cervical position sense in subjects with forward head posture. J Phys Ther Sci. 2014;26(11):1741-43.
[6] Jull GA, Falla D, Vicenzino B, Hodges PW. The effect of therapeutic exercise on activation of the deep cervical flexor muscles in people with chronic neck pain. Man Ther. 2009;14(6):696-701.
[7] Fathollahnejad K, Letafatkar A, Hadadnezhad M. The effect of manual therapy and stabilizing exercises on forward head and rounded shoulder postures: A six-week intervention with a one-month follow-up study. BMC Musculoskelet Disord. 2019;20(1):01-08.
[8] Ruivo RM, Pezarat-Correia P, Carita AI. Effects of a resistance and stretching training program on forward head and protracted shoulder posture in adolescents. J Manipulative Physiol Ther. 2017;40(1):1-10.
[9] Lee SM, Lee CH, O'Sullivan D, Jung JH, Park JJ. Clinical effectiveness of a pilates treatment for forward head posture. J Phys Ther Sci. 2016;28(7):2009-13.
[10] Shiravi S, Letafatkar A, Bertozzi L, Pillastrini P, Khaleghi Tazji M. Efficacy of abdominal control feedback and scapula stabilization exercises in participants with forward head, round shoulder postures and neck movement impairment. Sports Health. 2019;11(3):272-79.
[11] Battal G, Ali N, Chamoun R, Berthe HB. Does the addition of upper thoracic manipulation to proprioceptive training improve cervicocephalic joint position sense and forward head posture in asymptomatic college students? J Int Acad Phys Ther Res. 2021;12(2):2345-53.
[12] Blomgren J, Strandell E, Jull G, Vikman I, Röijezon U. Effects of deep cervical flexor training on impaired physiological functions associated with chronic neck pain: A systematic review. BMC Musculoskelet Disord. 2018;19:01-17.
[13] Yang S, Boudier-Revéret M, Yi YG, Hong KY, Chang MC. Treatment of chronic neck pain in patients with forward head posture: A systematic narrative review. Healthcare (Basel). 2023;11(19):2604.
[14] Suresh N, Rajashekar A. Effectiveness of proprioception training for patients with forward head posture (FHP): A literature review. Int J Multidiscip Res. 2023;5(5):01-08.

[15] Gallego Izquierdo T, Pecos-Martin D, Lluch Girbés E, Plaza-Manzano G, Rodríguez Caldentey R, Mayor Melús R, et al. Comparison of cranio-cervical flexion training versus cervical proprioception training in patients with chronic neck pain: A randomized controlled clinical trial. J Rehabil Med. 2016;48(1):48-55.
[16] Sikka I, Chawla C, Seth S, Alghadir AH, Khan M. Effects of deep cervical flexor training on forward head posture, neck pain, and functional status in adolescents using computers regularly. Biomed Res Int. 2020;2020:8327565.
[17] Salahzadeh Z, Maroufi N, Ahmadi A, Behtash H, Razmjoo A, Gohari M, et al. Assessment of forward head posture in females: Observational and photogrammetry methods. J Back Musculoskelet Rehabil. 2014;27(2):131-39.
[18] Saadat M, Salehi R, Negahban H, Shaterzadeh MJ, Mehravar M, Hessam M. Traditional physical therapy exercises combined with sensorimotor training: The effects on clinical outcomes for chronic neck pain in a double-blind randomized controlled trial. J Bodyw Mov Ther. 2019;23(4):901-07.
[19] Rix GD, Bagust J. Cervicocephalic kinesthetics sensibility in patients with chronic, nontraumatic cervical spine pain. Arch Phys Med Rehabil. 2001;82(7):911-19.
[20] Jull GA, O'Leary SP, Falla DL. Clinical assessment of the deep cervical flexor muscles: The craniocervical flexion test. J Manipulative Physiol Ther. 2008;31(7):525-33.

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